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Should Sub-Saharan Africa Expand Cotton Exports?

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and
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Sub-Saharan Africa's recent rapid expansion of cotton exports has not caused an "adding-up" problem. And further expansion of Sub-Saharan Africa's cotton exports is unlikely to have a significant impact on the world cotton market.

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This paper — a product of the International Trade Division, International Economics Department — is part of a larger effort in the department to evaluate the impact on world markets of policy changes in primary commodity-producing countries. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Grace Ilogon, room S7-033, extension 33732 (May 1993, 40 pages).

In the 1980s, cotton production in Sub-Saharan Africa expanded significantly. Annual production growth averaged 4.7 percent between 1980 and 1990, compared with only 1.2 percent for 1964-79. At the same time, cotton exports grew an average 8 percent a year, compared with almost no growth between 1964 and 1979.

Concern has been expressed, at the World Bank and elsewhere, about the "adding-up problem" of expanding exports for commodities that are highly price-inelastic. The concern has been that export expansion — as a result of project loans or structural adjustment programs — could lead to a fall in world prices and an overall reduction in export revenues.

Coleman and Thigpen assess whether expansion of cotton exports in Sub-Saharan African countries has produced an adding-up problem. They test the hypothesis that export expansion has led, or will lead, to a decline in the terms of trade, which would offset any benefits from export expansion.

Their results reject this hypothesis. Using comparative static analysis — comparing Sub-Saharan Africa's export share with estimated world demand elasticities — they show that Sub-Saharan Africa's 14 percent share of world exports is too small relative to the estimated price elasticity of demand (ranging from -0.2 to -0.3) to produce an adding-up problem.

Using an econometric model of the world fibers market, Coleman and Thigpen show that maintaining the high 1980s growth rate of cotton exports in the 1990s would increase Sub-Saharan African export revenues more than 50 percent by the end of the decade, compared with base-case projections. And, except when the price elasticity of world cotton demand is lowered substantially below its estimated value, estimates of the elasticity of export revenue relative to export volume were close enough to unity for Coleman and Thigpen to conclude that an adding-up problem does not exist for expanded cotton exports in Sub-Saharan Africa.

Their analysis also shows that the structural adjustment programs implemented in the 1980s are unlikely to have had a significant adverse impact on the world cotton market. A 20 percent real devaluation for all of Sub-Saharan Africa, for example, leads to an average 0.4 percent decline in the world price of cotton, while a 20 percent increase in producer cotton prices in all Sub-Saharan African countries leads to a 0.8 percent decline in the world price.

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1. Introduction

Sub-Saharan Africa (SSA) contains many countries where the agricultural sector is the predominant employer of the labor force and a major contributor to gross domestic product (GDP). While the major agricultural sector activity has been the production of food for domestic consumption, production of cash crops for export has received increasing attention in agricultural development programs during recent years. However, the heavy reliance on a limited number of export crops has resulted in extreme volatility of export earnings due to price fluctuations in international commodity markets. Akiyama and Larson (1989) highlighted this problem when they observed that the share of SSA's total agricultural export revenues accounted for by only two commodities--cocoa and coffee--had increased from 32% during the 1961-63 period to 54% in the 1984-86 period. In a more recent period (1987-89), sharp declines in the prices of those two commodities resulted in a major retrenchment in their contribution to income in the major producing countries and their share of SSA's agricultural export revenues fell to 36%.

Cotton has been developed during the last quarter of a century as an important exportable cash crop in many SSA countries, especially in the francophone countries. The area devoted to cotton growing varies from year to year in response to its market conditions relative to market prospects for crops that compete with it for cultivatable land. The possibility of annual adjustment of cotton production commitments results in much shorter price cycles in response to supply/demand imbalances than those normally occurring in tree crops such as cocoa and coffee. This adds to cotton's attractiveness as a diversification option to moderate the production and price risk of reliance on cocoa and coffee.

In the 1980s, cotton production in SSA expanded significantly. On average, the annual rate of growth between 1980 and 1990 was 4.7%, compared with only 1.2% for the period 1964-79. This high rate of expansion was largely due to growth in the francophone countries which recorded an expansion rate of almost 10% p.a. Production increases resulted from both yield improvements through the adoption of better technologies and an expansion in planted area. Associated with the production expansion has been a substantial growth in cotton exports. In the 1980s, exports grew at an annual average rate of 8% compared to almost no growth between 1964 and 1979. In the francophone countries, exports grew annually by 12%, while in anglophone Africa the rate was only 3%, but the latter was a reversal of the 2% p.a. decline in exports during the 1970s.

The effects of expanding commodity exports by developing countries have been of considerable interest within the World Bank and elsewhere (Godfrey (1985), Lele et al. (1989), DeRosa and Greene (1991)). The main issue centers on the so-called "adding-up problem". Concern is based on the fact that

some developing countries individually have large shares of world exports of primary commodities, the world demand for which is highly price-inelastic. In such cases, export expansion through World Bank loans for projects or as a result of policy advice could lead to a fall in world prices and lower overall export revenues. Lower world prices would not only adversely affect SSA producers but also other producing countries.

For this reason the IMF and World Bank have received criticism for recommending currency devaluations or reductions in export taxes. DeRosa and Greene state that:

> According to the critics [of World Bank adjustment programs], any gains in competitiveness for individual countries would be offset by a fall in the terms of trade resulting from devaluations and increases in export volume from other countries exporting the same products. The net result would be no gain - and perhaps even a decline - in total export earnings for countries that devalue. Given that African countries are principally exporters of primary commodities, there is concern that the devaluations undertaken by these countries will lead to a cumulative negative impact on their export prices and economic welfare.

The objective of this paper is to evaluate whether an adding-up problem has been present in the case of SSA's rapid expansion of cotton exports in the 1980s or could be a problem if SSA's cotton production continues to expand, as hoped. This evaluation involves the following steps. First, to determine whether individually, or as a group, SSA cotton producers are likely to exert pressure on world market prices by their own actions. This involves estimating income and price elasticities of world demand. The next step is to evaluate the impact of SSA's recent cotton export expansion, including the effects of structural adjustment programs, on the world cotton market. The final step is to evaluate the impact of possible further export expansion in the 1990s along the lines of development plans formulated.

The paper is organized into the following sections. In section 2, the structure and performance of the cotton market is reviewed. In section 3, a comparison is made between SSA's share of the world market and the price elasticity of demand for cotton. This provides *prima facie* evidence of whether or not an adding-up problem is present. Tests for an adding-up problem based on the elasticity of export value with respect to volume (ERV) are presented. Then in section 4, we use an econometric model of the world fibers market to investigate the impact of SSA's recent and likely production and export expansion on world prices and production in the rest of the world. In section 5, again using the model, we evaluate the impacts of structural adjustment programs which affected the SSA cotton sector directly (e.g., through changing producer prices and taxes) and indirectly (e.g., through changing macroeconomic variables, such as exchange rates). Finally, in section 6 we draw some conclusions from the study.

2. Recent Cotton Industry Developments in SSA

The performance of the cotton sector in the SSA region from the mid-1960s through the 1970s was poor. Cotton area peaked at 4.1 million hectares in 1971 and then declined to a low of 2.7 million hectares in 1981--a rate of decline of 3.8% p.a. The reduction in cotton area was partly due to crop substitution in response to heightened concern over food security, stimulated by an extended drought in the region. Civil unrest also disrupted cotton growing in several countries. Although the cotton area expanded in some countries during this period (e.g., Côte d'Ivoire, Kenya, Madagascar, Mali, Senegal, South Africa, and Tanzania), this expansion was more than offset by substantial reductions in other countries, especially in Angola, Cameroon, Central African Republic, Chad, Mozambique, Sudan, Uganda and Zaire. As a result, cotton production in the SSA region declined at an annual rate of 2.5% during the 1971-81 period, in spite of a moderate uptrend in cotton yields. Cotton exports from the region fell at an annual rate of 4.6%.

Interest in cotton growing in SSA recovered strongly during the 1980s, however (see Table 1). Cotton area increased at a rate of 0.6% p.a.; greatly improved husbandry practices and more adequate rainfall boosted yield increases to an annual rate of 4.1%; and production increased at a rate of 4.7% p.a. The expansion was focused on exports and export volumes increased at the substantial rate of 7.9% p.a.

The development of cotton growing during the 1980s was not uniform throughout the SSA region, however. Cotton production in the francophone countries benefitted greatly from sustained technical assistance, training, and the development of industry organizations specialized in cotton genetics, agronomics, crop financing, marketing, and extension education. The systematic and timely provision of appropriate technology, financing, and physical inputs for cotton cultivation, ginning and marketing, played an important role in the successful expansion of cotton production in these countries. The foundation of trained farmers established in the earlier years assisted in the acceleration of cotton growing during the 1980s. The use of yield-increasing inputs for cotton also contributed to improved food production.

Cotton area in the francophone region increased at a modest rate of 0.8% p.a. during the 1964-79 period but increased at 6.6% p.a. during the 1980-90 period (see Table 1). During the 1964-79 period, the increase in cotton production was derived mainly from increasing yields--the rate of yield increase was seven-fold the rate of acreage expansion. In the 1980s, yield increases moderated to 3% p.a.--still a high growth rate--and the expansion of cotton area accounted for over two-thirds of the 9.7% p.a. increase in cotton production. Average cotton yields in the francophone countries ranged from 16% to 38% lower than in the other SSA countries during the mid-1960s but, by 1990, their yields averaged 54% higher.

Table 1. Average Annual Growth Rates for Cotton in Francophone and Anglophone SSA.

	Area	Yield	Production	Exports
	(% p.a.)			
Francophone SSA				
1964-79	0.8	5.8	6.6	5.5
1980-90	6.6	3.0	9.7	12.0
1964-90	1.1	5.2	6.3	6.3
Non-francophone SSA				
1964-79	-0.8	0.1	-0.7	-1.7
1980-90	-2.1	2.6	0.5	3.1
1964-90	-2.1	1.2	-0.8	-2.0
SSA Total				
1964-79	-0.4	1.6	1.2	0.3
1980-90	0.6	4.1	4.7	7.9
1964-90	-1.2	2.7	1.5	-2.0

Source: Calculated from International Cotton Advisory Committee Data.

With mill consumption of cotton growing only slowly (at 0.1% p.a.) in the francophone countries, their export volume increased at an average rate of 12% p.a. in the 1980s. Exports increased from an annual average of 84,000 tons during the 1964-66 period to an average of 467,000 tons during the 1988-90 period. The share of SSA's cotton exports accounted for by the francophone countries increased from 20% in the mid-1960s to 55% in recent years.

In the other SSA countries, cotton area peaked in 1972 and declined in both sub-periods presented in Table 1. In those countries, average yields were virtually stagnant during the 1964-79 period but increased at a rate of 2.6% p.a. during the 1980-90 period. Cotton production increased at 3.8% p.a. between 1964 and 1974. Production declined sharply after 1975 due to the collapse of world cotton prices in the previous year, and because of the conversion of cotton area to production of foodcrops following the drought in the Sahel region of the continent. However, aggregate production recovered at

a moderate annual rate of 0.5% through 1990. As a result, average annual production of cotton in the non-francophone SSA region during the 1988-90 period was 5% lower than during the 1964-66 period. Cotton exports from these countries peaked at 514,000 tons in 1969 and 1970 before declining to 168,000 tons in 1981. With exports recovering only moderately through 1990, their average level during the most recent three seasons was 284,300 tons--16.5% lower than exports during the 1964-66 period.

Many of the policy constraints on cotton production in SSA have been or are in the process of being corrected. The period of extremely low world cotton prices in the mid-1980s, caused by the large increase in supply, led many SSA cotton producing countries to reform their production, trade, and pricing policies. Those reforms generally reduced input subsidies, ensured that producer prices reflected changes in world price levels, gave attention to the importance of exchange rates in external trade performance, and reorganized marketing systems to increase their operating efficiency.

The extent of the policy changes obviously varied by country and the results achieved have varied substantially. For example, in Nigeria the real exchange rate depreciated almost 300% between 1986 and 1990, while in Tanzania the currency depreciated by more than 450% between 1984 and 1990. In contrast, real exchange rates in the francophone countries were relatively stable during the 1980s. In terms of cotton specific policies, reforms in Mali included setting up incentives for the cotton corporation (CMDT) to maximize profits and the linking of domestic and international prices. In Chad, reforms of the cotton marketing parastatal (COTONCHAD) improved efficiency by requiring full cost recovery on inputs, and by closing several unprofitable ginning operations.

One indicator of the success of the adjustments made is a comparison of average cotton area and yield performance during the early 1980s (1980/81-1982/83) with performance during the latest three years for which data are available (1988/89-1990/91). The most dramatic results are evident in Benin, Burkina Faso, Mali and Togo (see Table 2). Cotton area in Benin increased more than three-fold while average yields increased by 46%. The increase in cotton area in Burkina Faso was 141%, while the increase in yields was 9%. In Mali, the cotton area increased by 115% while average yields increased by 13%. Similarly, in Togo, the cotton area increased by 209% and average yields increased by 26%. Other countries experiencing both increased cotton area and higher yields were Cameroon, Chad, Côte d'Ivoire, Malawi and South Africa.

Table 2. Cotton Area and Yields in SSA Countries, 1980-82 to 1988-90.

Country	Area ('000 Ha)		Yield (Kg/Ha)		Area	Yield
	1980-82	1988-90	1980-82	1988-90	% change	% change
Francophone						
Benin	24.0	103.7	319	466	+332	+46
Burkina Faso	70.7	170.7	354	387	+114	+9
Cameroon	62.7	98.3	489	539	+57	+10
C. Afr. Rep.	66.0	48.3	126	248	-27	+97
Chad	145.7	198.7	217	287	+36	+32
Côte d'Ivoire	126.3	205.0	472	571	+62	+21
Madagascar	18.3	23.3	546	544	+27	-0
Mali	89.0	191.7	479	541	+115	13
Senegal	34.7	33.0	384	454	-5	+18
Togo	26.0	80.3	359	452	+209	+26
Zaire	83.7	34.3	120	126	-59	+5
Non-Francophone						
Ethiopia	53.0	36.0	509	537	-32	+6
Kenya	119.3	55.7	70	162	-53	+131
Malawi	33.3	38.0	150	184	+14	+23
Mozambique	138.0	83.7	123	119	-39	-3
Nigeria	426.3	393.3	53	103	-8	+94
Sudan	380.7	262.7	401	443	-31	+10
South Africa	109.3	165.7	366	372	+52	+2
Tanzania	287.3	343.3	157	142	+19	-9
Uganda	139.0	43.3	48	146	-69	+204
Zambia	28.7	84.0	221	206	+193	-7
Zimbabwe	128.0	250.0	464	309	+95	-33

Source: Cotton World Statistics, ICAC, recent issues.

3. Tests for an Adding-Up Problem in Cotton Export Expansion by SSA

Godfrey (1985) in a discussion of the adding-up problem stated that:

> "A fair test of the hypothesis that volume growth leads to income growth is a comparison, for each commodity, of (a) SSA share of world exports with (b) world price elasticity of demand of the commodity. If (b) exceeds (a) it can be concluded that output and export of the commodity in question can be safely expanded."

In this section we provide estimates of the two components mentioned by Godfrey--SSA's share of world cotton exports and the price elasticity of demand for cotton. This provides *prima facie* evidence of whether or not an adding-up problem exists for cotton in SSA.

The share of world cotton production supplied by SSA is given in Table 3 and its share of world exports are shown in Table 4. Details for the larger cotton producing and exporting countries are also shown. Côte d'Ivoire is SSA's largest cotton producer with an average of 117,000 tons between 1988/89 and 1990/91. Other large producers with more than 100,000 tons are Sudan and Mali; together with Côte d'Ivoire these countries produce a little more than one-third of all SSA cotton. Other important producers from francophone Africa are Burkina Faso, Chad, Cameroon and Benin, while the major anglophone producers are Zimbabwe, South Africa, Tanzania and Nigeria. In all, total production in SSA averaged 960,000 tons over the past three seasons, about three-quarters of total supply from all African countries. (Egypt supplied most of the non-SSA cotton.) As shown in Table 3, SSA has a very small share of world production, averaging only 5% in recent years.

SSA's largest cotton exporters are Sudan, Mali, and Côte d'Ivoire which together accounted for 45% of SSA's exports over the past three seasons. Other major exporters include Zimbabwe, Burkina Faso and Chad, each with average exports greater than 50,000 tons. Overall, SSA has averaged 738,000 tons of cotton exports over the past three years, representing 94% of all African exports but only 14% of world exports.

Table 5 reports estimates of price elasticities of total fiber and cotton demand from a number of studies. Included in the table are the regions covered, the dependent variable (indicating whether the price elasticity is with respect to total fiber demand or mill consumption) and the period of estimation. The elasticities show the short-run impact of an increase in price on consumption. We were unable to find estimates of long-run elasticities. However, we expect the long-run elasticities to be larger than the short-run elasticities reflecting the possibility of greater substitutability over time. This is especial true for cotton mill consumption elasticities, given that manufacturers can substitute synthetic fibers for cotton quickly and at low cost.

Table 3. Cotton Production by Leading Producers, 1988/89 to 1990/91 1/.

Rank/ Country	1988/89	1989/90	1990/91	3-Year Average
	('000 tons)			
1. Côte d'Ivoire	128	107	116	117.0
2. Sudan	139	127	80	115.3
3. Mali	97	99	116	104.0
4. Zimbabwe	91	67	73	77.0
5. Burkina Faso	59	62	77	66.0
6. South Africa	78	60	49	62.3
7. Chad	53	58	60	57.0
8. Cameroon	69	43	47	53.0
9. Tanzania	63	36	47	48.7
10. Benin	44	42	59	48.3
11. Nigeria	48	38	36	40.7
12. Togo	33	34	41	36.0
13. Ethiopia	21	18	19	19.3
14. Zambia	17	10	25	17.3
15. Senegal	14	12	18	14.7
16. Madagascar	12	13	13	12.7
17. Cen.Afr.Rep.	11	11	14	12.0
18-31. Others	65	70	68	67.7
Total SSA	1,033	898	950	960
Africa Total	1,353	1,195	1,254	1,267
World Total	18,337	17,392	18,997	18,242
SSA Share (%) of:				
Africa	76	75	76	76
World	6	5	5	5

1/ Ranked on average production during the 1988/89 to 1990/91 period.
Source: ICAC, Cotton: World Statistics, April, 1992.

Table 4. Cotton Exports by Leading Exporters, 1988/89 to 1990/91 1/.

Rank/ Country	1988/89	1989/90	1990/91	3-Year Average
	('000 tons)			
1. Sudan	162	141	103	135.3
2. Mali	89	96	113	99.3
3. Côte d'Ivoire	101	111	80	97.3
4. Zimbabwe	82	63	49	64.7
5. Burkina Faso	60	61	72	64.3
6. Chad	48	48	57	51.0
7. Cameroon	59	38	45	47.3
8. Tanzania	62	37	37	45.3
9. Benin	39	46	51	45.3
10. Togo	31	31	38	33.3
11. Senegal	13	11	16	13.3
12. Cen.Afr.Rep.	8	10	8	8.7
13. Zambia	2	4	9	5.0
14. Mozambique	5	5	4	4.7
15. South Africa	5	3	4	4.0
16. Uganda	2	2	4	2.7
17. Madagascar	1	2	3	2.0
18. Kenya	1	1	2	1.3
19-31. Others	22	16	14	17.3
Total SSA	784	725	705	738
Africa Total	852	769	727	783
World Total	5,704	5,249	5,006	5,320
SSA Share (%) of:				
Africa	92	94	97	94
World	14	14	14	14

1/ Ranked on average exports during the 1988/89 to 1990/91 period.
Source: ICAC, Cotton: World Statistics, April, 1992.

Table 5. Estimates of Demand Price Elasticities for Total Fibers and Cotton.

Study	Region	Dependent Variable	Period	Elasticity
Donald et al. (1963)	United States	Fiber Demand	1948-60	-0.14
Dudley (1974)	World	Fiber Demand	1953-70	-0.25
Thigpen (1978)	Industrial Countries	Cotton Demand	1955-75	-0.20
	Developing Countries	Cotton Demand	1955-75	-0.09
Adams & Behrman (1976)	Developing Countries	Fiber Demand	1955-73	-0.23
Mues & Simmons (1988)	Europe	Mill Consumption	1954-86	-0.26
	United States	Mill Consumption	1954-86	-0.34
	Rest-of-World	Mill Consumption	1954-86	-0.10
Coleman & Thigpen (1991)	World	Mill Consumption	1964-88	-0.24

Total fiber and cotton demand tends to be inelastic with respect to price. The range of elasticities from the studies surveyed is from -0.10 to -0.34, with a mean elasticity of -0.21 and a median of -0.23. Possible explanations for the differences in estimates include the geographical area covered (e.g., industrial or developing countries) and the period of estimation, both of which are shown in Table 5.

While the demand for cotton is inelastic, for only a few estimates is the absolute value of the elasticity lower than the SSA share of world cotton exports (14%). This is evidence against the existence of an adding-up problem from expansion of cotton production from SSA. However, additional evidence can be generated through simulations of a world cotton model and the results of these are reported in the following sections.

Akiyama (1993) has noted a confusion in the treatment of the adding-up problem. According to Akiyama, the approach taken by Godfrey is flawed because it ignores costs. Akiyama argues that "... marginal revenue might be considerably lower than marginal cost before (a) = (b), at which point marginal revenue becomes zero."

An alternative definition of the adding-up problem is "a very small or even negative increase in export revenues in proportion to an increase in export volume". More formally, this definition can be expressed as:

$$ERV = \frac{\%\Delta R}{\%\Delta Q} = \frac{\delta R}{\delta Q} \cdot \frac{Q}{R} < 1$$

where:

ERV	=	Elasticity of export revenue with respect to export volume,
R	=	Export revenue, and
Q	=	Export volume.

An adding-up problem exists when the "small country" assumption does not apply (i.e., when the production and/or exports of a country significantly affect the world price), such that an increase in export volume reduces world prices significantly and the ERV is significantly less than unity. For commodities with price elasticities of demand less than unity, the ERV will decline for even small increases in export volumes. However, an adding-up problem can be said to exist only in cases where the ERV falls considerably below unity or becomes negative. The ERV is positively related to the price elasticity of import demand facing the country and the elasticity of supply in the rest of the world, and negatively related to the countries' world trade share--all of which tend to change over time. Preferably, therefore, the ERVs facing SSA for increases in cotton exports should be calculated using a model of the world cotton market. This has been done and the results are reported in the next section.

4. Impact of SSA Cotton Export Expansion on the World Market

As reported in section 2, cotton exports by SSA countries expanded at an average rate of 7.9% p.a. during the 1980s (see Table 1). Recently, concern has been expressed over whether continuation of such rapid growth is desirable because it could push down world prices and lead to lower total export revenues (i.e., there could be an adding-up problem). To examine this issue, an econometric model of the world cotton and fibers market was simulated to measure the impact of different rates of export

expansion by SSA[1]. The model was simulated from 1992/93 through to 2000/01 in order to provide base forecasts of price, production and consumption in the cotton and non-cellulosic fibers sectors. This required that values for all the exogenous variables be evaluated for each year to the end of the simulation period. Annual percent growth rates in income and population for each region were used to project the levels of these variables for each year between 1992/93 and 2000/01. Exchange rates and consumer price indexes were set at their 1991/92 values, thus assuming that purchasing power parity was maintained over the long-run and projected prices are in 1991/92 constant US$ terms.

The analysis is presented in terms of how world cotton market projections (for the period 1992/93-2000/01) change under alternative scenarios about SSA cotton exports. The results of two simulations of the model are reported in Tables 6 and 7. The results from the base simulation (referred to as 'Base' in the tables) indicate that SSA cotton exports will grow from 775,000 tons in 1992/93 to 900,000 tons in 2000/01, an increase of about 1.8% annually[2]. In the second simulation (referred to as 'Shock' in the tables), it was assumed that SSA maintains the same growth in the 1990s as it did in the 1980s. That is, exports are assumed to expand at 7.9% annually in the forecast period.

In order for exports to expand at the accelerated rate, production would have to reach 1 million tons by 2000/01, an increase of 524,000 tons over the base production projection. The larger exports do cause the world price of cotton to be lower than they otherwise would be (see Table 7). In the base simulation the world cotton price is projected to increase at 2.7% p.a., reaching US¢162/kg by 2000/01 (prices are in 1990 constant US$ terms). With the accelerated exports, the price is projected to increase at a rate of only 2.2% p.a., reaching US¢156/kg by the end of the decade. On average, the price difference is US¢3/kg over the simulation period. With the lower world prices, cotton production in non-SSA countries is reduced 0.72% on average, equivalent to about 138,000 tons, while world mill consumption is increased by about 35,000 tons (up 0.2%). As a result of lower production, exports from non-SSA countries decline on average by 86,000 tons (down 2.1%). Finally, lower export volumes and prices result in lower export revenues received by non-SSA developing countries, 3.7% lower on average in real terms over the simulation period.

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[1]The model is fully documented in Coleman and Thigpen (1991).

[2]The substantial reduction in growth rate results from recent stagnation in the cotton sectors of many francophone countries, especially Burkina Faso, Côte d'Ivoire, and Mali. As well, high growth rates during the 1980s reflect low base level exports in the early 1980s.

Table 6. Projected Impact of Cotton Export Expansion on SSA Cotton Market, to 2000/01.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
SSA Production ('000 tons)										
Base	945	870	885	890	911	932	954	977	1,000	929
Shock	945	916	987	1,049	1,129	1,217	1,312	1,413	1,524	1,166
Change	0	46	102	159	218	284	357	437	524	236
% Change	0.00	5.28	11.51	17.83	23.95	30.49	37.41	44.68	52.35	24.83
SSA Exports ('000 tons)										
Base	775	790	800	815	831	848	865	882	900	834
Shock	775	836	902	974	1,050	1,133	1,223	1,320	1,425	1,071
Change	0	46	102	159	219	285	358	438	525	237
% Change	0.00	5.82	12.75	19.51	26.30	33.61	41.39	49.61	58.33	27.48
SSA Real Value of Net Exports (millions of 1990 US$)										
Base	102	108	123	130	134	138	141	144	146	130
Shock	102	114	138	154	167	181	194	208	222	164
Change	0	6	15	24	33	43	53	64	76	35
% Change	0.00	5.68	12.23	18.43	24.51	30.97	37.72	44.73	52.07	25.15
SSA Consumption ('000 tons)										
Base	410	410	415	415	416	417	418	419	420	416
Shock	410	410	415	415	416	418	419	420	421	416
Change	0	0	0	0	0	1	1	1	1	1
% Change	0.00	0.02	0.04	0.08	0.12	0.16	0.22	0.28	0.35	0.14

Source: IECIT, World Bank.

Market to

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
Real Cotton Price (¢/kg constant 1990 US$)										
Base	131	137	154	160	161	163	163	163	162	155
Shock	131	137	153	159	159	160	158	158	156	152
Change	0	0	-1	-1	-2	-3	-4	-5	-6	-3
% Change	0.00	-0.13	-0.46	-0.90	-1.42	-1.98	-2.60	-3.26	-3.95	-1.63
World Production ('000 tons)										
Base	20,100	18,500	19,000	19,500	20,042	20,600	21,173	21,762	22,320	20,333
Shock	20,100	18,541	19,050	19,575	20,139	20,718	21,314	21,928	22,511	20,431
Change	0	41	50	75	96	118	141	166	191	98
% Change	0.00	0.22	0.26	0.38	0.48	0.57	0.67	0.76	0.86	0.47
World Consumption ('000 tons)										
Base	18,840	19,260	19,625	20,000	20,409	20,826	21,252	21,687	22,130	20,448
Shock	18,840	19,266	19,637	20,020	20,439	20,867	21,306	21,755	22,213	20,483
Change	0	6	12	20	30	41	54	68	83	35
% Change	0.00	0.03	0.06	0.10	0.15	0.20	0.25	0.31	0.38	0.16
Exports of Other Developing Countries ('000 tons)										
Base	3,725	3,825	3,860	3,905	3,939	3,974	4,009	4,044	4,080	3,929
Shock	3,725	3,825	3,837	3,860	3,868	3,873	3,872	3,867	3,859	3,843
Change	0	0	-23	-45	-71	-101	-137	-177	-221	-86
% Change	0.00	-0.01	-0.58	-1.14	-1.80	-2.55	-3.42	-4.38	-5.42	-2.14
Value of Exports of Other Developing Countries (millions of 1990 US$)										
Base	488	523	593	625	634	648	652	659	662	609
Shock	488	523	587	612	614	619	614	610	601	585
Change	0	-1	-6	-13	-20	-29	-39	-49	-61	-24
% Change	0.00	-0.14	-1.04	-2.03	-3.19	-4.48	-5.93	-7.49	-9.16	-3.72

Source: IECIT, World Bank.

As far as SSA cotton export revenues are concerned, the increase in export volume overwhelms the negative price effect and on average export revenues are US$35 million (measured in constant 1990 US$) higher in the projection period--representing an increase of 25%. So, in effect, rather than declining, export revenues increase due to faster export growth. These results indicate that it is unlikely that there is an adding-up problem for expanded SSA cotton exports. The main explanation for this result is that SSA countries, even when taken as a group, are small players in the world market with only 14% of exports.

Additional evidence against the existence of an adding-up problem is provided in Table 8. Elasticities of export revenue with respect to volume (ERV) for each year of the simulation period are calculated. Using the estimated parameters of the model, the ERV for 1993/94 was 0.98. Throughout the simulation period, the ERVs declined, falling to 0.89 by 2000/01 and averaging 0.93. The decline is the result of a steady decline in world price throughout the simulation period relative to the base simulation (see Table 7). However, for the entire period, ERVs are sufficiently close to unity to conclude that an adding-up problem should not arise with expanded cotton exports by SSA.

While, the simulation results reported above indicate the adding-up problem should be of little concern, it is important to test under what dynamic circumstances (e.g., lower price and income demand elasticities, and slower GDP growth) an adding-up problem could arise. To investigate the sensitivity of the results to changes in model parameters, three additional simulations were undertaken. These were with: (i) the price elasticity of demand set at -0.1 instead of -0.2 as in the base; (ii) the income elasticity of demand set a 0.25 instead of 0.5; and (iii) a per capita GDP growth rate of 1% p.a. instead of 2% p.a. as in the base. These parameter changes would tend to increase the likelihood of there being an adding-up problem for expanded SSA cotton exports. The sensitivity of the ERVs to these parameter changes are reported in Table 8, while results for key variables are shown in the tables in the Annex.

With the price elasticity of demand set at -0.1 the ERV in 1993/94 is 0.77 and by 1995/96 it falls to 0.55 as the world price declines significantly below the base level. Towards the end of the decade, the decline in the world price stabilizes relative to the base and causes the ERV to increase. By 2000/01 the ERV reaches 0.67 and averages 0.63 for the period.

Lowering the income elasticity of demand or lowering the GDP growth projections result in a lower consumption growth path and hence lower world price and production. As shown in Table 8, lowering the income elasticity of demand to 0.25 leads to a small reduction in the ERVs compared to the base. For example, in 1993/94, a 1% increase in exports led to a 0.96% increase in export revenues, compared to 0.99% in the base run. By 2000/01, the ERV has fallen to 0.9, only 0.03 below the base

Table 8. Estimates of the Elasticity of Revenue with Respect to Volume for an Expansion of Cotton Exports by SSA.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
	---------- Elasticity of Revenue with Respect to Volume ----------									
Base Parameters 1/	0.00	0.98	0.96	0.94	0.93	0.92	0.91	0.90	0.89	0.93
Sensitivity to Price Elasticity of Demand 2/	0.00	0.77	0.62	0.55	0.56	0.60	0.63	0.66	0.67	0.63
Sensitivity to Income Elasticity of Demand 3/	0.00	0.96	0.94	0.92	0.90	0.89	0.87	0.86	0.85	0.90
Sensitivity to Income Growth Rate 4/	0.00	0.96	0.94	0.92	0.90	0.89	0.88	0.87	0.86	0.90

Source: IECIT, World Bank.
1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.
2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.
3/ Income Elasticity of Demand = 0.25; Other Parameters as in Base Simulation.
4/ Income Growth Rate = 1%; Other Parameters as in Base Simulation.

ERV. This shows that, even with the income elasticity of demand halved, the ERV is sufficiently close to unity to suggest no adding-up problem from expanded SSA cotton exports. Similar results were found when the growth rate of income was set at 1% p.a. instead of 2% p.a. In this case, the ERV averaged 0.9 over the simulation period, compared to 0.93 in the base. This suggests that income would have to grow at considerably less than 1% annually before an adding-up problem would arise.

5. Impact of Structural Adjustment Programs in SSA on the World Cotton Market.

During the 1980s, many SSA countries embarked on structural adjustment programs (SAPs) designed to restore economic growth and stability. As part of the SAPs, some SSA countries introduced measures to liberalize their commodity export markets. Policy changes included the removal of trade restrictions, price controls and export taxes. In addition to policy changes directed specifically at the commodity sectors, general economic policies had a major impact on production and export of agricultural commodities, particularly through exchange rate depreciation which improved the competitiveness of SSA exports.

While both sector-specific and macroeconomic policies have improved incentives to produce and export cotton, it is possible that the resulting supply response from improved incentives led to sufficiently lower world prices to offset any benefits in terms of export revenues. Thus, the fibers model was used to evaluate the impact of the SAPs on the world cotton market. To measure their impact on the SSA cotton sector and on the world market, the model was simulated under different assumptions about exchange rates and cotton prices received by producers. The purpose of these simulations was not to provide a thorough *ex post* evaluation of the structural adjustment programs with respect to the cotton sector. This would require a much larger effort including estimation of cotton supply and demand curves for each of the 32 cotton producing countries in SSA, evaluation of the individual cotton marketing and macroeconomic policy changes, and assessment of what would have been the economic structure and performance of the cotton sectors in the absence of the structural adjustment programs. Instead, our approach was limited to measuring the impacts of a real currency devaluation and an increase in cotton producer prices for all SSA countries.

5.1. Impact of a 20% Real Currency Devaluation in SSA

The estimated impact of a 20% devaluation in SSA countries as reflected in key variables in the SSA and in the world cotton market is reported in Tables 9 and 10. As in section 4, the analysis was

undertaken in terms of changes in market projections for the period 1992/93-2000/01[3].

The initial effect of the devaluation is to cause SSA producer prices of cotton to increase by about the same amount in percentage terms (i.e., 20%)[4]. This causes a supply response with SSA production and exports increasing 4% on average over the projection period (see Table 9), indicating a supply elasticity of 0.2 when all crop and input prices are considered. The supply response is modest because the own-price elasticity of cotton supply is fairly small (about 0.6) and because the devaluation causes the prices of inputs used in producing cotton (e.g., fertilizers and chemicals) to increase as well. In addition, the devaluation increases the profitability of producing crops which competing with cotton for cultivatable land such as rice, soybeans and maize.

With larger cotton exports entering the world market (averaging 34,000 tons), the world price projection is reduced on average by -0.3%, less than US¢1/kg (see Table 10). World production is higher on average by 11,000 tons--the net result of an additional 34,000 tons from SSA and a decline of 23,000 tons in the rest of the world in response to the lower world prices. World mill consumption increases in response to the lower world price but by less than 0.5%. With lower production in non-SSA countries, exports from other developing countries fall on average by 15,000 tons, valued at US$4 million. Despite the lower world price, the value of cotton exported by SSA increases with the 20% real devaluation, averaging US$5 million higher in the forecast period, an increase of about 3.8%. These results indicate that exchange rate devaluations in the 1980s were unlikely to have had a major adverse impact on the world cotton market and that they could have provided substantial benefits to SSA in terms of export revenues and producer incomes.

In order to test further whether there is an adding-up problem associated with the 20% real devaluation, ERVs were calculated for years between 1992/93 and 2000/01. These are reported in Table 11. To examine the sensitivity of the results to parameter assumption, the model was simulated with the price and income elasticities of demand and the GDP growth rate set at half their base simulation levels. The ERVs for these simulations are also reported in Table 11.

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[3]Given that purchasing power parity is assumed to hold in the projection period, in the base simulation the nominal exchange rates and consumer price indexes are assumed constant and fixed at their 1991/92 values. The 20% real devaluation is introduced by increasing the value of the 1991/92 nominal exchange rate by 20%, keeping the price indexes at their original values, and maintaining these throughout the simulation period.

[4]We assume that price liberalization also takes place so that domestic prices are determined by world prices and exchange rates.

Table 9. Impact of 20% Real Devaluation on SSA Cotton Market.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
SSA Production ('000 tons)										
Base	945	870	885	890	911	932	954	977	1,000	929
Shock	945	909	922	928	949	971	993	1,016	1,041	964
Change	0	39	37	38	38	39	39	39	41	34
% Change	0.00	4.48	4.24	4.23	4.17	4.13	4.08	4.00	4.13	3.72
SSA Exports ('000 tons)										
Base	775	790	800	815	831	848	865	882	900	834
Shock	775	829	837	853	869	886	904	921	940	868
Change	0	39	37	38	38	38	39	39	40	34
% Change	0.00	4.92	4.68	4.60	4.56	4.53	4.49	4.41	4.42	4.07
SSA Real Value of Net Exports (millions of 1990 US$)										
Base	102	108	123	130	134	138	141	144	146	130
Shock	102	113	128	136	139	144	146	150	152	135
Change	0	5	5	6	6	6	6	6	6	5
% Change	0.00	4.82	4.41	4.27	4.20	4.15	4.09	4.01	4.02	3.77
SSA Consumption ('000 tons)										
Base	410	410	415	415	416	417	418	419	420	416
Shock	410	410	415	415	416	417	418	419	421	416
Change	0	0	0	0	0	0	0	0	1	0
% Change	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.35	0.06

Source: IECIT, World Bank.

Table 10. Impact of 20% Real Devaluation on World Cotton Market.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
Real Cotton Price (¢/kg constant 1990 US$)										
Base	131	137	154	160	161	163	163	163	162	155
Shock	131	137	153	160	160	163	162	162	162	154
Change	0	0	0	-1	-1	-1	-1	-1	-1	0
% Change	0.00	-0.10	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.38	-0.28
World Production ('000 tons)										
Base	20,100	18,500	19,000	19,500	20,042	20,600	21,173	21,762	22,320	20,333
Shock	20,100	18,526	19,015	19,511	20,053	20,609	21,182	21,771	22,329	20,344
Change	0	26	15	11	10	9	9	9	9	11
% Change	0.00	0.14	0.08	0.06	0.05	0.05	0.04	0.04	0.04	0.05
World Consumption ('000 tons)										
Base	18,840	19,260	19,625	20,000	20,409	20,826	21,252	21,687	22,130	20,44[illegible]
Shock	18,840	19,263	19,630	20,006	20,416	20,833	21,259	21,695	22,138	20,453
Change	0	3	5	6	7	7	7	8	8	6
% Change	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03
Exports of Other Developing Countries ('000 tons)										
Base	3,725	3,825	3,860	3,905	3,939	3,974	4,009	4,044	4,080	3,929
Shock	3,725	3,820	3,848	3,889	3,921	3,955	3,989	4,023	4,058	3,914
Change	0	-5	-12	-16	-18	-19	-20	-21	-22	-15
% Change	0.00	-0.13	-0.32	-0.40	-0.45	-0.48	-0.51	-0.52	-0.54	-0.37
Value of Exports of Other Developing Countries (millions of 1990 US$)										
Base	488	523	593	625	634	648	652	659	662	609
Shock	488	522	590	621	629	643	646	653	656	605
Change	0	-1	-3	-5	-5	-5	-6	-6	-6	-4
% Change	0.00	-0.23	-0.57	-0.72	-0.79	-0.85	-0.88	-0.90	-0.92	-0.65

Source: IECIT, World Bank.

Table 11. Estimates of the Elasticity of Revenue with Respect to Volume for a 20% Real Devaluation by SSA.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
	Elasticity of Revenue with Respect to Volume									
Base Parameters 1/	0.00	0.98	0.94	0.93	0.92	0.92	0.91	0.91	0.91	0.93
Sensitivity to Price Elasticity of Demand 2/	0.00	0.76	0.14	-0.49	-0.84	-0.91	-0.91	-0.92	-0.88	-0.51
Sensitivity to Income Elasticity of Demand 3/	0.00	0.99	0.93	0.84	0.77	0.71	0.66	0.60	0.56	0.76
Sensitivity to Income Growth Rate 4/	0.00	0.99	0.92	0.84	0.77	0.72	0.67	0.63	0.60	0.77

Source: IECIT, World Bank.
1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.
2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.
3/ Income Elasticity of Demand = 0.25; Other Parameters as in Base Simulation.
4/ Income Growth Rate = 1%; Other Parameters as in Base Simulation.

Using the base simulation parameters, the ERV for a 20% real devaluation averaged 0.93 over the simulation period, falling from 0.98 in 1993/94 to 0.91 in 2000/01. The ERVs are close enough to unity to conclude that no adding-up problem would occur with such a policy change. However, reducing the price elasticity of demand to -0.1 (from -0.2) results in a significant fall in the ERV estimates. In fact, three years into the simulation period the ERV becomes negative, indicating that export revenues fall as export volumes expand. On average, the ERV is -0.51, indicating that a one percent increase in exports by SSA would lead to a decline in their exports revenue by about one-half of one percent. This result is generated by the fall in the world cotton price. On average, the price is 7.8% below the base simulation with a price elasticity of -0.1, compared to only 0.3% below the base with an elasticity of -0.2. Therefore, if the price elasticity of demand for cotton were -0.1, ceteris paribus a 20% devaluation of the real exchange rate by SSA would lead to an adding-up problem. However, it is unlikely that the price elasticity of demand has been overestimated. More likely it has been underestimated as econometric estimates of elasticity parameters are usually unable to take account of influences such as substitution which raise the price elasticity over the long term.

As expected, the ERVs for simulations assuming a lower income elasticity of demand and slower GDP growth rate are smaller than in the base simulation, averaging 0.76 and 0.77, respectively, over the projection period. In neither case, however, is the ERV significantly below unity. Therefore, it can be concluded that a 20% real devaluation would not lead to an adding-up problem if the income elasticity of demand for cotton or the GDP growth rate were much lower than the base case.

5.2. Impact of 20% Increase in Cotton Producer Prices in SSA

The impact of a 20% increase in cotton producer prices is reported in Tables 12 and 13. The SSA supply responses are in the same direction as reported for the 20% devaluation, however, they are larger in this case because there is no increase in the prices of inputs and competing crops to offset the higher cotton prices.

Production in SSA increases on average by about 10% or 96,000 tons (see Table 12). All the additional production is exported, leading to a slightly lower world price forecast--on average by less than 1% or US¢1/kg (see Table 13). With lower cotton prices, production in non-SSA countries is reduced 0.34% on average, equivalent to about 66,000 tons. In addition, the lower prices raises world mill consumption. Increasing producer prices has a positive impact on SSA export revenues, raising them an average of US$14 million over the forecast period. However, the volume and value of exports from other developing countries is reduced by 1% and 2%, respectively.

ERV calculated for the years between 1992/93 and 2000/01 are reported in Table 14. Again, to examine the sensitivity of the results to parameter assumptions, the model was simulated for the same producer price change with the price and income elasticities of demand and GDP growth rate set at half their base simulation levels. Under base simulation parameters, the ERV falls from 0.98 in 1993/94 to 0.93 in 1994/95, and thereafter slowly declines to 0.90 by the end of the decade. Assuming demand is the more inelastic with respect to price causes the ERV to fall significantly below unity. Over the simulation period, the ERV averages 0.33, reaching as low as 0.12 in 1998/99. The results are less sensitive to changes in the income elasticity of demand and the GDP growth rate. In simulations with these parameters set at half their base simulation levels, the ERVs average 0.86 over the analysis period, thus remaining above the level at which an adding-up problem would exist. Therefore, as in the case of expanded exports under a real devaluation, an adding-up problem would not exist for a 20% producer price increase, except if the price elasticity of demand was substantially less than its estimated value.

6. Conclusions

The purpose of this paper was to assess whether an adding-up problem exists in the case of cotton export expansion by countries in SSA. This issue has arisen following the fast growth in SSA cotton exports which averaged almost 8% in the 1980s. Part of the concern derives from questions about the impact of the structural adjustment programs which have increased incentives to produce cotton in some countries in SSA. The hypothesis tested in the paper was that export expansion has led or will lead to a decline in the terms of trade in cotton which offsets any benefits from export expansion.

Results from the analysis presented in the paper rejected this hypothesis. Using comparative static analysis, a comparison of SSA's export share with estimated world demand elasticities showed that its share of world exports (14%) is too small relative to the estimated price elasticity of demand (ranging between -0.2 and -0.3) for an adding-up problem to exist. Using an econometric model of the world fibers market, it was shown that maintaining the growth rate of cotton exports in the 1990s at the same high rate as in the 1980s caused SSA export revenues to be increased by more than 50% by the end of the decade, as compared with the base case projection. Also, except when the price elasticity of world cotton demand was lowered substantially below its estimated value, estimates of the ERVs were sufficiently close to unity to conclude that an adding-up problem does not exist for expanded cotton exports by SSA.

The analysis also showed that the structural adjustment programs implemented in the 1980s were unlikely to have had a significant adverse impact on the world cotton market. For example, a 20% real

devaluation for all of SSA led to an average decline in the world cotton price of about 0.4%, while a 20% increase in producer cotton prices caused a 0.8% decline in the world price. It is important to remember that these results are for SSA as a whole, so that individual SSA countries would have a negligible impact if they were to individually introduce policy changes of the magnitude analyzed.

Table 12. Impact of 20% Increase in Producer Cotton Price on SSA Cotton Market.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
SSA Production ('000 tons)										
Base	945	870	885	890	911	932	954	977	1,000	929
Shock	945	992	993	994	1,015	1,037	1,060	1,084	1,109	1,025
Change	0	122	108	104	104	105	105	107	109	96
% Change	0.00	14.04	12.17	11.73	11.43	11.21	11.04	10.95	10.86	10.38
SSA Exports ('000 tons)										
Base	775	790	800	815	831	848	865	882	900	834
Shock	775	912	907	918	934	951	969	988	1,007	929
Change	0	122	107	103	103	103	104	105	107	95
% Change	0.00	15.40	13.33	12.65	12.36	12.16	12.01	11.95	11.89	11.30
SSA Real Value of Net Exports (millions of 1990 US$)										
Base	102	108	123	130	134	138	141	144	146	130
Shock	102	124	138	146	149	154	156	159	162	143
Change	0	16	15	15	15	15	15	16	16	14
% Change	0.00	15.05	12.46	11.62	11.27	11.03	10.87	10.81	10.74	10.43
SSA Consumption ('000 tons)										
Base	410	410	415	415	416	417	418	419	420	416
Shock	410	410	416	416	417	418	420	421	422	417
Change	0	0	1	1	1	1	2	2	2	1
% Change	0.00	0.12	0.27	0.31	0.34	0.35	0.36	0.37	0.38	0.28

Source: IECIT, World Bank.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
Real Cotton Price (¢/kg constant 1990 US$)										
Base	131	137	154	160	161	163	163	163	162	155
Shock	131	136	153	159	159	162	161	161	161	154
Change	0	0	-1	-1	-2	-2	-2	-2	-2	-1
% Change	0.00	-0.30	-0.77	-0.91	-0.97	-1.00	-1.02	-1.02	-1.02	-0.78
World Production ('000 tons)										
Base	20,100	18,500	19,000	19,500	20,042	20,600	21,173	21,762	22,320	20,333
Shock	20,100	18,580	19,040	19,529	20,068	20,624	21,196	21,785	22,343	20,363
Change	0	80	40	29	25	23	23	23	23	30
% Change	0.00	0.43	0.21	0.15	0.13	0.11	0.11	0.10	0.10	0.15
World Consumption ('000 tons)										
Base	18,840	19,260	19,625	20,000	20,409	20,826	21,252	21,687	22,130	20,448
Shock	18,840	19,270	19,641	20,018	20,428	20,845	21,272	21,707	22,151	20,464
Change	0	10	16	18	19	19	20	20	21	16
% Change	0.00	0.05	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.08
Exports of Other Developing Countries ('000 tons)										
Base	3,725	3,825	3,860	3,905	3,939	3,974	4,009	4,044	4,080	3,929
Shock	3,725	3,810	3,823	3,860	3,890	3,922	3,954	3,987	4,022	3,888
Change	0	-15	-37	-45	-49	-52	-55	-57	-58	-41
% Change	0.00	-0.40	-0.97	-1.16	-1.24	-1.32	-1.37	-1.41	-1.42	-1.03
Value of Exports of Other Developing Countries (millions of 1990 US$)										
Base	488	523	593	625	634	648	652	659	662	609
Shock	488	520	583	612	620	633	637	643	646	598
Change	0	-4	-10	-13	-14	-15	-15	-16	-16	-11
% Change	0.00	-0.71	-1.73	-2.06	-2.20	-2.30	-2.37	-2.41	-2.43	-1.80

Source: IECIT, World Bank.

Table 14. Estimates of the Elasticity of Revenue with Respect to Volume for a 20% Increase in Cotton Producer Price.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
	---------- Elasticity of Revenue with Respect to Volume ----------									
Base Parameters 1/	0.00	0.98	0.93	0.92	0.91	0.91	0.91	0.90	0.90	0.92
Sensitivity to Price Elasticity of Demand 2/	0.00	0.91	0.65	0.35	0.18	0.13	0.12	0.13	0.14	0.33
Sensitivity to Income Elasticity of Demand 3/	0.00	1.00	0.95	0.89	0.85	0.83	0.80	0.78	0.76	0.86
Sensitivity to Income Growth Rate 4/	0.00	0.99	0.95	0.89	0.85	0.83	0.81	0.79	0.78	0.86

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.

3/ Income Elasticity of Demand = 0.25; Other Parameters as in Base Simulation.

4/ Income Growth Rate = 1%; Other Parameters as in Base Simulation.

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Annex I

Table for Sensitivity Analysis

Table A1. Expansion of Cotton Exports by SSA. Sensitivity of Simulation Results to Price Elasticity of Demand.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
		% change from base simulation								
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.13	-0.46	-0.90	-1.42	-1.98	-2.60	-3.26	-3.95	-1.63
SSA Export Revenues	0.00	5.68	12.23	18.43	24.51	30.97	37.72	44.73	52.07	25.15
Other Developing Country Export Revenues	0.00	-0.14	-1.04	-2.03	-3.19	-4.48	-5.93	-7.49	-9.16	-3.72
Sensitivity to Price Elasticity of Demand 2/										
World Cotton Price										
Total	0.00	-1.29	-4.24	-7.29	-9.26	-10.15	-10.80	-11.42	-12.03	-7.39
% from SSA Export Expansion	0.00	-0.14	-0.51	-1.02	-1.62	-2.26	-2.97	-3.72	-4.50	-1.86
% from Demand & Supply Shifts	0.00	-1.15	-3.73	-6.27	-7.64	-7.88	-7.83	-7.70	-7.52	-5.53
SSA Export Revenues										
Total	0.00	4.46	7.97	10.80	14.61	20.05	26.13	32.53	39.29	17.31
% from SSA Export Expansion	0.00	5.67	14.64	21.30	27.15	32.88	38.79	44.92	51.38	26.30
% from Demand & Supply Shifts	0.00	-1.22	-6.67	-10.50	-12.54	-12.82	-12.66	-12.39	-12.09	-8.99
Other Developing Country Export Revenues										
Total	0.00	-1.35	-9.37	-15.73	-19.78	-21.74	-23.31	-24.87	-26.39	-15.84
% from SSA Export Expansion	0.00	-0.15	-1.10	-2.12	-3.29	-4.60	-6.07	-7.66	-9.35	-3.81
% from Demand & Supply Shifts	0.00	-1.20	-8.27	-13.61	-16.49	-17.14	-17.24	-17.21	-17.04	-12.02

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.

Table A2. Expansion of Cotton Exports by SSA. Sensitivity of Simulation Results to Income Elasticity of Demand.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
					% change from base simulation					
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.13	-0.46	-0.90	-1.42	-1.98	-2.60	-3.26	-3.95	-1.63
SSA Export Revenues	0.00	5.68	12.23	18.43	24.51	30.97	37.72	44.73	52.07	25.15
Other Developing Country Export Revenues	0.00	-0.14	-1.04	-2.03	-3.19	-4.48	-5.93	-7.49	-9.16	-3.72
Sensitivity to Income Elasticity of Demand 2/										
World Cotton Price										
Total	0.00	-0.19	-0.68	-1.35	-2.10	-2.88	-3.71	-4.58	-5.46	-2.33
% from Export Expansion	0.00	-0.13	-0.46	-0.90	-1.42	-1.98	-2.60	-3.27	-3.97	-1.64
% from Demand & Supply Shifts	0.00	-0.06	-0.22	-0.45	-0.68	-0.90	-1.11	-1.31	-1.50	-0.69
SSA Export Revenues										
Total	0.00	5.62	11.98	17.90	23.65	29.76	36.14	42.76	49.68	24.17
% from Export Expansion	0.00	5.76	12.67	19.06	25.34	31.95	38.81	45.88	53.24	25.86
% from Demand & Supply Shifts	0.00	-0.14	-0.69	-1.17	-1.69	-2.19	-2.67	-3.12	-3.56	-1.69
	0.00	-0.62	-3.71	-5.86	-8.40	-10.97	-13.52	-15.99	-18.58	-8.63
Other Developing Country Export Revenues										
Total	0.00	-0.20	-1.55	-3.03	-4.71	-6.48	-8.41	-10.43	-12.53	-5.26
% from Export Expansion	0.00	-0.14	-1.04	-2.02	-3.17	-4.44	-5.86	-7.39	-9.00	-3.67
% from Demand & Supply Shifts	0.00	-0.07	-0.51	-1.01	-1.54	-2.04	-2.55	-3.05	-3.52	-1.59

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.

Table A3. Expansion of Cotton Exports by SSA. Sensitivity of Simulation Results to GDP Growth Rate.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
					% change from base simulation					
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.13	-0.46	-0.90	-1.42	-1.98	-2.60	-3.26	-3.95	-1.63
SSA Export Revenues	0.00	5.68	12.23	18.43	24.51	30.97	37.72	44.73	52.07	25.15
Other Developing Country Export Revenues	0.00	-0.14	-1.04	-2.03	-3.19	-4.48	-5.93	-7.49	-9.16	-3.72
Sensitivity to Income Growth Rate 2/										
World Cotton Price										
Total	0.00	-0.20	-0.70	-1.37	-2.10	-2.85	-3.64	-4.45	-5.28	-2.29
% from Export Expansion	0.00	-0.13	-0.46	-0.90	-1.42	-1.98	-2.60	-3.27	-3.97	-1.64
% from Demand & Supply Shifts	0.00	-0.07	-0.24	-0.46	-0.68	-0.87	-1.04	-1.18	-1.31	-0.65
SSA Export Revenues										
Total	0.00	5.61	11.96	17.87	23.65	29.80	36.24	42.95	49.98	24.23
% from Export Expansion	0.00	5.77	12.70	19.09	25.35	31.92	38.74	45.77	53.10	25.83
% from Demand & Supply Shifts	0.00	-0.15	-0.74	-1.21	-1.70	-2.13	-2.51	-2.83	-3.12	-1.60
	0.00	-0.68	-3.97	-6.10	-8.46	-10.66	-12.68	-14.49	-16.28	-8.15
Other Developing Country Export Revenues										
Total	0.00	-0.21	-1.58	-3.07	-4.72	-6.43	-8.25	-10.16	-12.11	-5.17
% from Export Expansion	0.00	-0.14	-1.04	-2.02	-3.17	-4.44	-5.86	-7.40	-9.02	-3.68
% from Demand & Supply Shifts	0.00	-0.07	-0.54	-1.05	-1.55	-1.99	-2.39	-2.76	-3.09	-1.49

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.

Table A4. 20% Real Devaluation by SSA. Sensitivity of Simulation Results to Price Elasticity of Demand.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
	% change from base simulation									
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.10	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.38	-0.28
SSA Export Revenues	0.00	4.82	4.41	4.27	4.20	4.15	4.09	4.01	4.02	3.77
Other Developing Country Export Revenues	0.00	-0.23	-0.57	-0.72	-0.79	-0.85	-0.88	-0.90	-0.92	-0.65
Sensitivity to Price Elasticity of Demand 2/										
World Cotton Price										
Total	0.00	-1.15	-3.84	-6.55	-8.00	-8.28	-8.24	-8.12	-7.95	-7.80
% from SSA Devaluation	0.00	0.00	-0.10	-0.28	-0.35	-0.39	-0.41	-0.42	-0.42	-0.27
% from Demand & Supply Shifts	0.00	-1.15	-3.73	-6.27	-7.64	-7.88	-7.83	-7.70	-7.52	-5.53
SSA Export Revenues										
Total	0.00	3.72	0.66	-2.25	-3.81	-4.12	-4.12	-4.07	-3.88	-1.99
% from SSA Devaluation	0.00	4.94	2.53	3.76	4.34	4.35	4.21	4.05	3.96	3.57
% from Demand & Supply Shifts	0.00	-1.22	-1.87	-6.01	-8.15	-8.47	-8.34	-8.12	-7.84	-5.56
	0.00	-0.55	14.90	2.10	-4.20	-5.00	-4.41	-3.68	-2.83	-2.10
Other Developing Country Export Revenues										
Total	0.00	-1.20	-8.50	-14.20	-17.20	-18.00	-18.10	-18.10	-17.90	-17.80
% from SSA Devaluation	0.00	0.00	-0.23	-0.59	-0.71	-0.86	-0.86	-0.89	-0.86	-0.55
% from Demand & Supply Shifts	0.00	-1.20	-8.27	-13.61	-16.49	-17.14	-17.24	-17.21	-17.04	-12.02

Source: IECIT, World Bank.
1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.
2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.

Table A5. 20% Real Devaluation by SSA. Sensitivity of Simulation Results to Income Elasticity of Demand.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.10	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.38	-0.28
SSA Export Revenues	0.00	4.82	4.41	4.27	4.20	4.15	4.09	4.01	4.02	3.77
Other Developing Country Export Revenues	0.00	-0.23	-0.57	-0.72	-0.79	-0.85	-0.88	-0.90	-0.92	-0.65
Sensitivity to Income Elasticity of Demand 2/										
World Cotton Price										
Total	0.00	-0.06	-0.32	-0.70	-1.00	-1.24	-1.47	-1.68	-1.87	-0.93
% from SSA Devaluation	0.00	0.00	-0.10	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.24
% from Demand & Supply Shifts	0.00	-0.06	-0.22	-0.45	-0.68	-0.90	-1.11	-1.31	-1.50	-0.69
SSA Export Revenues										
Total	0.00	4.86	4.34	3.87	3.52	3.23	2.95	2.65	2.47	3.10
% from SSA Devaluation	0.00	4.92	-0.11	8.59	8.25	8.02	7.79	7.54	7.40	5.82
% from Demand & Supply Shifts	0.00	-0.07	4.45	-4.73	-4.74	-4.79	-4.85	-4.89	-4.93	-2.73
	0.00	-0.03	37.42	-34.88	-33.75	-33.05	-32.34	-31.58	-30.94	-17.68
Other Developing Country Export Revenues										
Total	0.00	-0.07	-0.73	-1.58	-2.25	-2.83	-3.38	-4.40	-5.02	-2.25
% from SSA Devaluation	0.00	0.00	-0.23	-0.57	-0.71	-0.78	-0.83	-1.36	-1.50	-0.66
% from Demand & Supply Shifts	0.00	-0.07	-0.51	-1.01	-1.54	-2.04	-2.55	-3.05	-3.52	-1.59

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.Source: IECIT, World Bank.

Table A6. 20% Real Devaluation by SSA. Sensitivity of Simulation Results to GDP Growth Rate.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
	% change from base simulation									
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.10	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.38	-0.28
SSA Export Revenues	0.00	4.82	4.41	4.27	4.20	4.15	4.09	4.01	4.02	3.77
Other Developing Country Export Revenues	0.00	-0.23	-0.57	-0.72	-0.79	-0.85	-0.88	-0.90	-0.92	-0.65
Sensitivity to Income Growth Rate 2/										
World Cotton Price										
Total	0.00	-0.07	-0.34	-0.72	-1.00	-1.22	-1.40	-1.56	-1.69	-0.89
% from SSA Devaluation	0.00	0.00	-0.10	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.24
% from Demand & Supply Shifts	0.00	-0.07	-0.24	-0.46	-0.68	-0.87	-1.04	-1.18	-1.31	-0.65
SSA Export Revenues										
Total	0.00	4.85	4.32	3.85	3.51	3.25	3.02	2.78	2.66	3.14
% from SSA Devaluation	0.00	4.92	-0.10	8.58	8.25	8.04	7.84	7.62	7.52	5.85
% from Demand & Supply Shifts	0.00	-0.07	4.43	-4.73	-4.74	-4.78	-4.82	-4.84	-4.86	-2.71
	0.00	-0.03	37.33	-34.78	-33.73	-33.19	-32.72	-32.26	-31.09	-17.93
Other Developing Country Export Revenues										
Total	0.00	-0.07	-0.77	-1.62	-2.26	-2.77	-3.23	-3.63	-3.97	-2.04
% from SSA Devaluation	0.00	0.00	-0.23	-0.57	-0.71	-0.78	-0.83	-0.87	-0.88	-0.54
% from Demand & Supply Shifts	0.00	-0.07	-0.54	-1.05	-1.55	-1.99	-2.39	-2.76	-3.09	-1.49

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.Source: IECIT, World Bank.

Table A7. 20% in Producer Price of Cotton. Sensitivity of Simulation Results to Price Elasticity of Demand.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
					% change from base					
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.30	-0.77	-0.91	-0.97	-1.00	-1.02	-1.02	-1.02	-0.78
SSA Export Revenues	0.00	15.05	12.46	11.62	11.27	11.03	10.87	10.81	10.74	10.43
Other Developing Country Export Revenues	0.00	-0.71	-1.73	-2.06	-2.20	-2.30	-2.37	-2.41	-2.43	-1.80
Sensitivity to Price Elasticity of Demand 2/										
World Cotton Price										
Total	0.00	-1.15	-4.12	-7.33	-9.01	-9.40	-9.41	-9.30	-9.13	-6.54
% from Price Change	0.00	0.00	-0.39	-1.06	-1.37	-1.51	-1.58	-1.60	-1.60	-1.01
% from Demand & Supply Shifts	0.00	-1.15	-3.73	-6.27	-7.64	-7.88	-7.83	-7.70	-7.52	-5.53
SSA Export Revenues										
Total	0.00	14.07	8.65	4.40	2.23	1.62	1.47	1.54	1.68	3.96
% from Price Change	0.00	15.29	15.32	14.90	14.77	14.44	14.13	13.93	13.77	12.95
% from Demand & Supply Shifts	0.00	-1.22	-6.67	-10.50	-12.54	-12.82	-12.66	-12.39	-12.09	-8.99
	0.00	0.55	120.20	104.40	100.30	99.80	100.10	100.90	102.50	80.97
Other Developing Country Export Revenues										
Total	0.00	-1.20	-9.13	-15.79	-19.27	-20.23	-20.50	-20.56	-20.45	-14.13
% from Price Change	0.00	0.00	-0.86	-2.18	-2.78	-3.08	-3.26	-3.36	-3.40	-2.10
% from Demand & Supply Shifts	0.00	-1.20	-8.27	-13.61	-16.49	-17.14	-17.24	-17.21	-17.04	-12.02

Source: IECIT, World Bank.

1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.

2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.Source: IECIT, World Bank.

Table A8. 20% Increase in Producer Price of Cotton. Sensitivity of Simulation Results to Income Elasticity of Demand.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
	% change from base									
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.30	-0.77	-0.91	-0.97	-1.00	-1.02	-1.02	-1.02	-0.78
SSA Export Revenues	0.00	15.05	12.46	11.62	11.27	11.03	10.87	10.81	10.74	10.43
Other Developing Country Export Revenues	0.00	-0.71	-1.73	-2.06	-2.20	-2.30	-2.37	-2.41	-2.43	-1.80
Sensitivity to Income Elasticity of Demand 2/										
World Cotton Price										
Total	0.00	-0.06	-0.53	-1.23	-1.62	-1.90	-2.15	-2.38	-2.58	-1.38
% from Price Change	0.00	0.00	-0.31	-0.78	-0.94	-1.00	-1.04	-1.07	-1.08	-0.69
% from Demand & Supply Shifts	0.00	-0.06	-0.22	-0.45	-0.68	-0.90	-1.11	-1.31	-1.50	-0.69
SSA Export Revenues										
Total	0.00	15.33	12.72	11.27	10.54	10.03	9.60	9.29	9.00	9.75
% from Price Change	0.00	15.47	13.41	12.43	12.23	12.22	12.27	12.41	12.56	11.44
% from Demand & Supply Shifts	0.00	-0.14	-0.69	-1.17	-1.69	-2.19	-2.67	-3.12	-3.56	-1.69
	0.00	0.03	121.50	106.50	102.90	102.40	102.70	103.40	104.90	82.70
Other Developing Country Export Revenues										
Total	0.00	-0.07	-1.22	-2.75	-3.63	-4.29	-4.92	-5.50	-6.03	-3.16
% from Price Change	0.00	0.00	-0.71	-1.74	-2.09	-2.25	-2.37	-2.46	-2.51	-1.57
% from Demand & Supply Shifts	0.00	-0.07	-0.51	-1.01	-1.54	-2.04	-2.55	-3.05	-3.52	-1.59

Source: IECIT, World Bank.
1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.
2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.Source: IECIT, World Bank.

Table A9. 20% Increase in Producer Price of Cotton. Sensitivity of Simulation Results to GDP Growth Rate.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Average
					% change from base					
Base Simulation Parameters 1/										
World Cotton Price	0.00	-0.30	-0.77	-0.91	-0.97	-1.00	-1.02	-1.02	-1.02	-0.78
SSA Export Revenues	0.00	15.05	12.46	11.62	11.27	11.03	10.87	10.81	10.74	10.43
Other Developing Country Export Revenues	0.00	-0.71	-1.73	-2.06	-2.20	-2.30	-2.37	-2.41	-2.43	-1.80
Senaitivity to Income Growth Rate 2/										
World Cotton Price										
Total	0.00	-0.07	-0.55	-1.25	-1.62	-1.87	-2.08	-2.25	-2.39	-1.34
% from Price Change	0.00	0.00	-0.31	-0.78	-0.94	-1.00	-1.04	-1.07	-1.08	-0.69
% from Demand & Supply Shifts	0.00	-0.07	-0.24	-0.46	-0.68	-0.87	-1.04	-1.18	-1.31	-0.65
SSA Export Revenues										
Total	0.00	15.32	12.71	11.25	10.54	10.06	9.68	9.43	9.22	9.80
% from Price Change	0.00	15.47	13.44	12.46	12.24	12.19	12.18	12.26	12.34	11.40
% from Demand & Supply Shifts	0.00	-0.15	-0.74	-1.21	-1.70	-2.13	-2.51	-2.83	-3.12	-1.60
	0.00	0.03	121.50	106.40	102.90	102.40	102.70	103.40	104.90	82.69
Other Developing Country Export Revenues										
Total	0.00	-0.07	-1.26	-2.79	-3.64	-4.24	-4.76	-5.21	-5.59	-3.06
% from Price Change	0.00	0.00	-0.71	-1.75	-2.09	-2.25	-2.37	-2.45	-2.51	-1.57
% from Demand & Supply Shifts	0.00	-0.07	-0.54	-1.05	-1.55	-1.99	-2.39	-2.76	-3.09	-1.49

Source: IECIT, World Bank.
1/ Price Elasticity of Demand = - 0.2; Income Elasticity of Demand = 0.5; Growth Rate in Real GDP = 2% p.a.
2/ Price Elasticity of Demand = - 0.1; Other Parameters as in Base Simulation.Source: IECIT, World Bank.

Annex

The relationship between the share of world market and demand elasticity is shown below.

Let
- Q = quantity of cotton exports by SSA,
- P = world price of cotton,
- TR = total cotton export revenues of SSA ($P.Q$),
- Q^* = total world cotton exports,
- α = share of total world cotton exports supplied by SSA (Q/Q^*),
- ϵ = elasticity of demand for cotton.

An adding-up problem exists if $dTR/dQ < 0$.

Totally differentiating TR with respect to Q gives,

$$\frac{dP}{dQ}.Q + P < 0$$

or

$$\frac{1}{\frac{dQ}{dP}.\frac{1}{Q}} + P < 0$$

and

$$\frac{1}{\frac{\frac{dQ}{Q^*}.Q^*}{\frac{dP}{P}_P}.\frac{1}{Q}} + P < 0$$

Therefore,

$$\frac{1}{\epsilon}.\frac{Q}{Q^*}.P + P < 0$$

or,

$$\frac{1}{\epsilon}.\alpha + 1 < 0$$

and,

$$|\epsilon| < \alpha$$

Therefore, an adding-up problem exists when the share of cotton exports from SSA exceeds the price elasticity of demand. Using the base parameters, SSA export revenues were 57.13% higher from the export expansion, while the export revenues of other developing country cotton exporters and the world cotton price were lower by 1.76% and 0.76%, respectively. With lower price elasticity, the export expansion causes the world price to fall more sharply. By 2000/01, the price is 8.% below the base level with a price elasticity of -0.1, compared to -1.76 with an elasticity of -0.2. The price decline causes export revenues of SSA to be only 31% above the base level instead of 57% with the higher demand elasticity. However, export revenues still remain substantially higher from export expansion, indicating that an adding-up problem would not exist even if the price elasticity of demand were -0.1. In fact, with a price elasticity of zero, an adding-up problem still was not found. This is because consumption growth due to higher income and from lower prices to offset the expansion in exports.

As adding-up problem could arise if consumption growth is reduced so that less of the additional exports are consumed. In the model this can be done by either lowering the income elasticity of demand or GDP growth rate. With an income elasticity of only 0.25 the decline in world cotton price is less than with an elasticity of 0.5. However, as seen in Table 8, by 2000/01 the decline is only 2.35% compared to 1.76%. The export revenue falls to 5.3% lower than in the base than with an elasticity of 0.5. Finally, the percentage change in world price due to export expansion with GDP growth of 1% is -2.13% in 2000/01, compared to -1.76% with a 2% p.a. growth rate.

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